Due on May 12th 2020 (11:00 am)

NAME: David Kirby **MAXIMUM POINTS: 100**

ECE 322L: Electronics-II (Spring 2020, University of New Mexico)

FINAL EXAMINATION

INSTRUCTIONS:

- Write your name on the top left corner
- Write your answers on separate sheets of paper
- Specify the question id (e.g., Q1) on the separate sheets of paper that you are using to provide your answers

Each question is worth 4 points. In order to receive full credit, you will have to concisely justify your answers.

Q1. Consider a forward-biased Si diode with I_D=1 mA. Next, I_D is increased to 10 mA. Circle the true statement below.

(a) The diffusion capacitance C_d decreases and junction capacitance C_j increases.

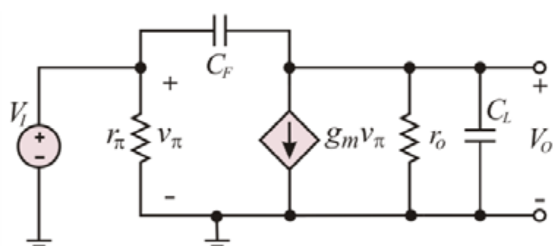
(b) The diffusion capacitance C_d increases and junction capacitance C_j decreases.

(c) Only the diffusion capacitance C_d increases.

(d) Only the junction capacitance C_j increases.

Q2. (True/False) BJTs and MOSFETs are two electrically symmetrical devices, i.e. one can, in principle interchange the drain (collector) and the source (emitter) terminals without affecting device behavior.

Q3. Which capacitor yields the dominant upper corner frequency in the circuit below? Circuit parameters are r_π=2.5 KΩ, r_o=100 KΩ, g_m=40 mS, and C_L=C_F=1 nF?



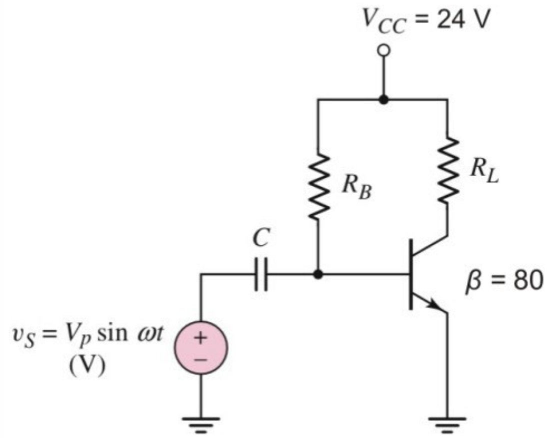
Q4. Would you select a large or a small BJT to amplify a high frequency signal?

Q5. What is the frequency response of the amplifier below?

(a) High-pass

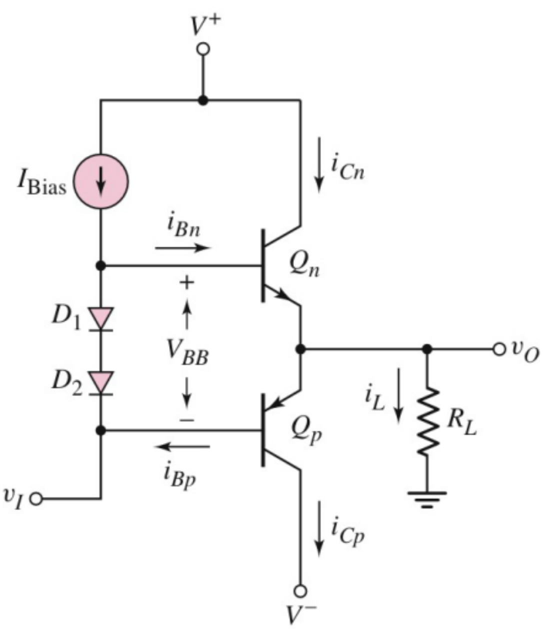
(b) Low-pass

(c) Band-pass.



Q6. (True/False) The diffusion capacitance of a pn junction is negligible when the junction is reverse-biased.

Q7. Write down one phrase/sentence that describes the purpose of the diodes and constant current source in the amplifier below.



Q8. Any damage to a power transistor is prevented if the __________________ lays _____________the SOA.

Q9. The output stage of a voltage amplifier
(a) is typically a source/emitter follower.
(b) often includes a power transistor
(c) has low output resistance
(d) All of the above.

Q10. A BJT has rated power of 115 W at T_{case}=25° C and maximum allowable junction temperature $T_{j,max}$= 200° C . The transistor is dissipating 5 W at an ambient temperature T_A=25° C. As it is required to operate the BJT at 60° C, a heat sink is needed. Which heat sink would you select?

(a) One with a $\theta_{case\text{-}sink}$=1° C/W and a $\theta_{sink\text{-}ambient}$=4° C/W

(b) One with a $\theta_{case\text{-}sink}$=4° C/W and a $\theta_{sink\text{-}ambient}$=10° C/W

(c) $\theta_{case\text{-}sink}$=1° C/W and a $\theta_{sink\text{-}ambient}$=1° C/W

(d) More information is needed to appropriately select a heat sink.

Q11. (True/False) The maximum safe power dissipation in a device is directly proportional to the temperature difference between the device and the ambient.

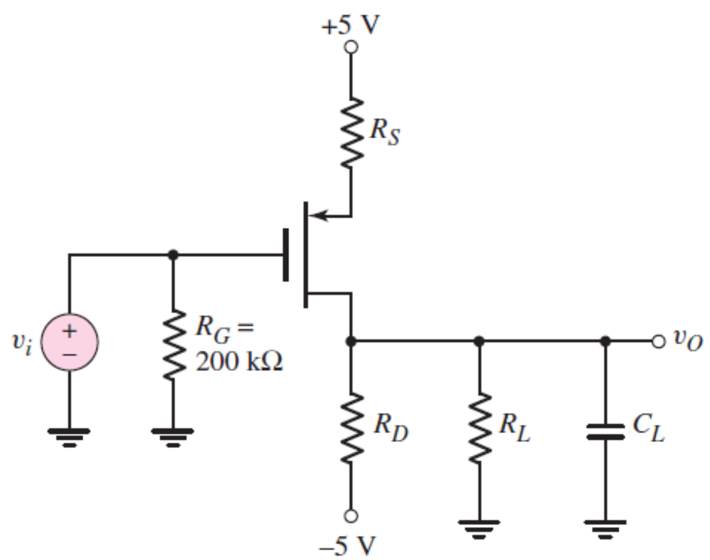
Q12. (True/False) Inserting a bypass capacitor in a common emitter amplifier circuit will decrease the upper corner frequency of the amplifier.

Q13. Name one amplifier configuration whose performance is not limited by the Miller effect.

Q14. Assume you are process engineer with the assigned task to reduce the Miller effect in a MOSFET. What is your strategy?

Q15. In an npn BJT, C_μ ______________at increasing V_{CE}.

Q16. Sketch the frequency response of the amplifier below.



Q17. (True/False) For a MOSFET in saturation C_{gs}=C_{gd}.

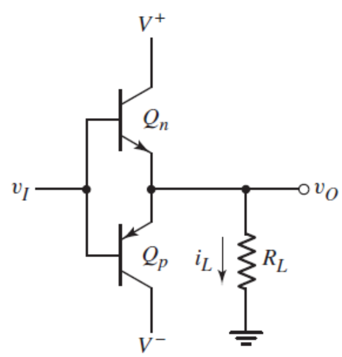
Q18. Assume your output signal suffers from cut-off clipping. Would you move your Q point up or down the ac load line, in order to avoid this distortion?

Q19. Why is a class A amplifier so inefficient?

Q20. Sketch the collector current of a pnp in a class AB push-pull-stage.

Q21. In a npn operating in saturation mode C_μ is a________________________ capacitance.

Q22. Sketch and label the voltage-transfer-characteristic of the stage below for values of the $v_{CEn} > V_{CE,sat}$ and the $v_{ECp} > V_{EC,sat}$.



Q23. (True/False) A Darlington pair can be implemented using MOSFETs to obtain a very high current gain at midband.

Q24. (True/False) At increasing ambient temperature the SOA of a transistor remains unchanged.

Q25. (True/False) Using a BJT with a large-area B-C junction will reduce the Miller effect in a CE amplifier.

Q1. (c) Only the diffusion capacitance C_d increases.
C_d is directly proportional to the forward current. Also, junction capacitance is typical of reverse-biased diodes, not forward, as C_j is a voltage-dependent capacitance.

Q2. False
While MOSFETs are electrically symmetrical devices, BJTs are not symmetrical; interchanging the collector and the emitter makes the BJT leave the forward active mode and operate in reverse mode instead.

Q3. C_F yields the dominant upper corner frequency.
Since both capacitors are the same value, we can look at the resistances on the output and the input. r_0 is larger than r_π and will result in a smaller f_H, making it the dominant upper corner frequency.

Q4. Small BJT

Q5. (a) High-pass
The coupling capacitor produces a high-pass response.

Q6. True
Diffusion capacitance is directly proportional to the forward current and is therefore negligible when in reverse bias.

Q7. The diodes and constant current source are meant to eliminate crossover distortion and provide small quiescent bias to the output transistors.

Q8. load line / within

Q9. (d) All of the above.
Voltage amplifiers characteristically have low output resistance, this is also one of the benefits of using an emitter follower.

Q10. (b) One with a $\theta_{\text{case}-\text{sink}} = 4\frac{°\text{C}}{\text{W}}$ and a $\theta_{\text{sink}-\text{ambient}} = 10\frac{°\text{C}}{\text{W}}$
Since the ambient temperature is 25°C, we would need to dissipate an additional 35°C to meet the operating temperature requirements. This cannot be met by the other options.

Q11. True
$P_{D,max} = \frac{T_{j,max} - T_{amb}}{\theta}$

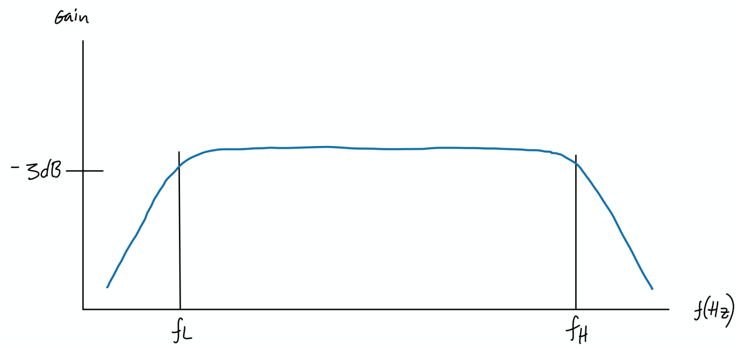
Q12. False
Bypass capacitors affect the lower corner frequency of the amplifier, not upper corner.

Q13. Common-base configuration is not affected by the Miller effect because there is no capacitor between the input and the output. The base is grounded and acts as a shield to the collector.

Q14. Reduce the capacitance between input and output which can be achieved by reducing the area of the junction. We could implement a cascode configuration which would use a common-base to limit the Miller effect.

Q15. is more parasitic

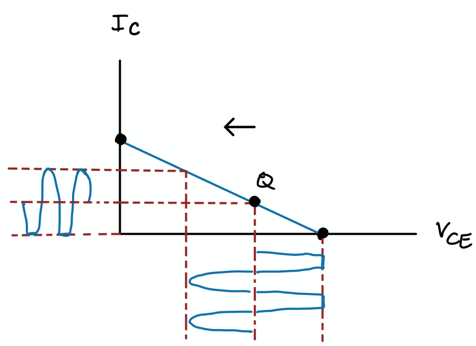
Q16. Frequency response of C-S



Q17. False

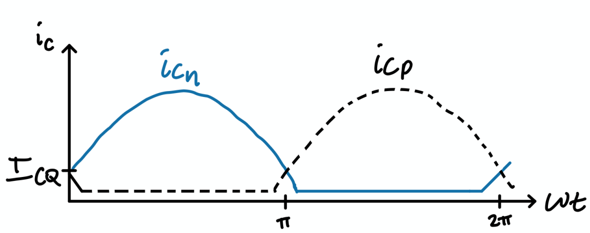
$C_{gs} \approx C_{gd}$ for non-saturation region.

Q18. For cutoff clipping, you would move the Q point up the ac load line (see figure below).



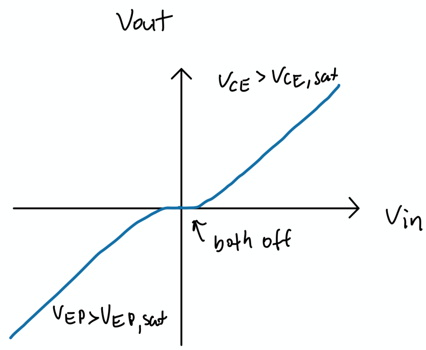
Q19. Class A amplifiers are inefficient because the load applied is not just resistive but also has an inductive or capacitive element. As a result, power is supplied to the load during only half a period while during the other half of the period the load supplies power to the biasing network.

Q20. Sketch of collector current



Q21. Reverse-biased junction

Q22. VTC for Class B amplifier



Q23. False
Darlington pairs use BJTs, not MOSFETs.

Q24. True
SOA is based on $I_{C,max}$, $V_{CE(sus)}$ and P_T, these already take into account ambient temperature.

Q25. False
Larger area would result in greater parasitic capacitance.

Comment Summary